Dehumidifier

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Priority number(s): GB19910003193 19910214

Abstract of **GB2252738**

A dehumidifier (10) has a fan (12) which blows air to be dehumidified through a series of absorber plates (14) down which are running droplets of relatively concentrated aqueous lithium chloride liquor which absorbs water vapour. The now weaker lithium chloride solution is passed to a boiler (40) where it is heated to produce steam and a relatively concentrated liquor. The steam/liquor is passed to a separator (28) from which the steam is condensed and collected in a reservoir (74) and the liquor is delivered to the absorber plates. The plates (14) may comprise acrylic sheet faced with glass fibre tissue and are arranged below distribution plate (20) comprising layers of glass fibre paper.

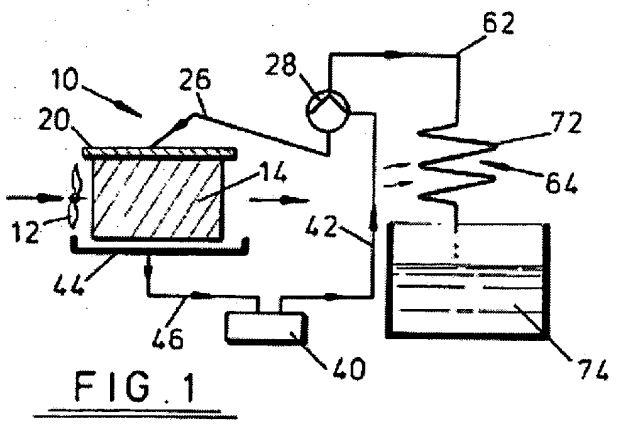

FIG. 1

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(56) Documents cited
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US 4915838 A US 4864830 A US 4178158 A
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(58) Field of search
UK CL (Edition K) B1L LAE LAH LAJ
INT CL[5] B01D
Online databases: WPI, CHEMENG

(54) Dehumidifier

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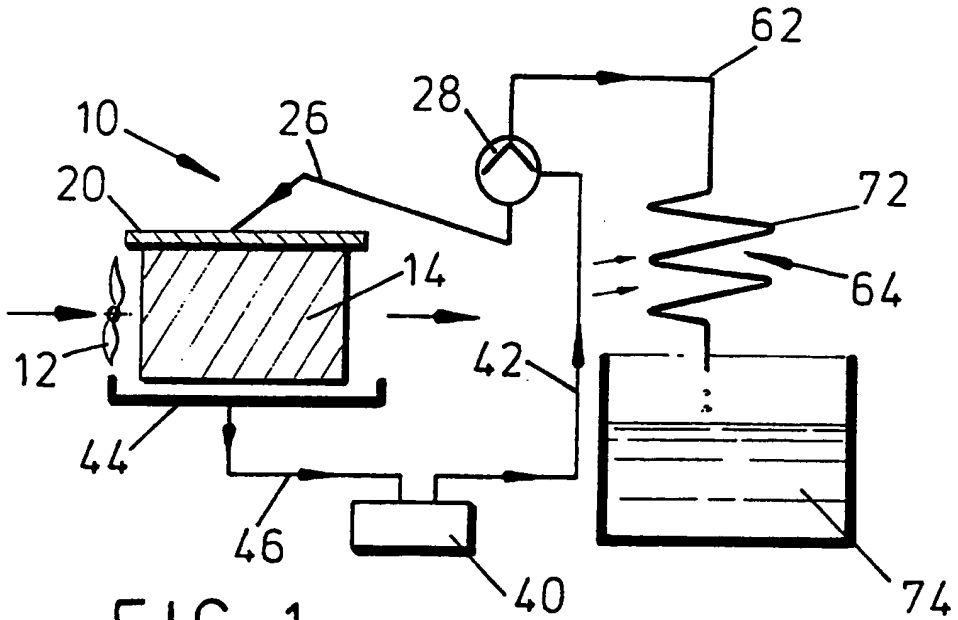

FIG. 1

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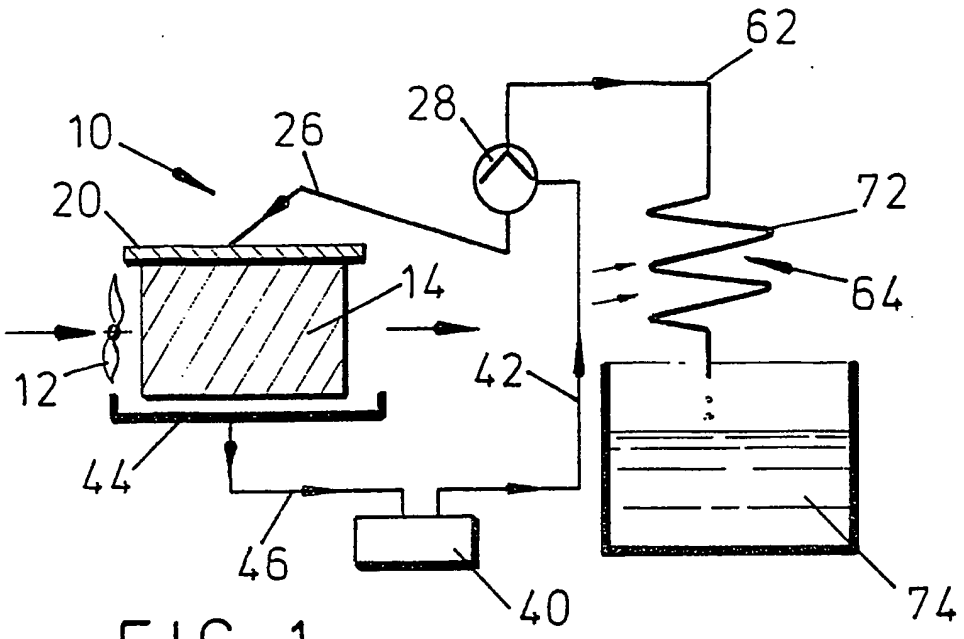

FIG. 1

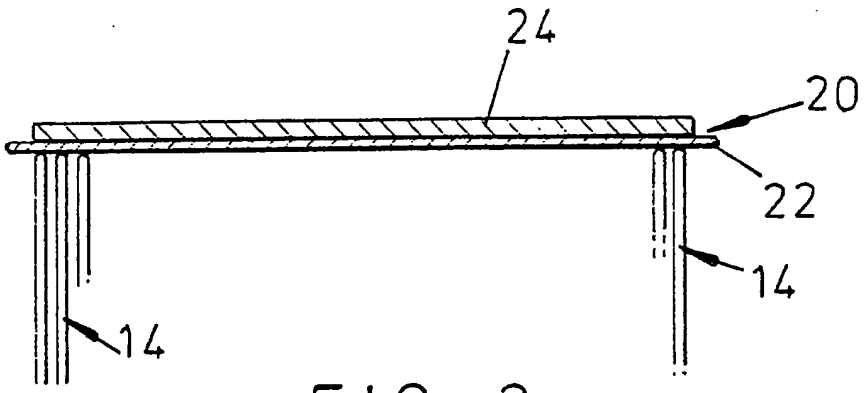

FIG. 2

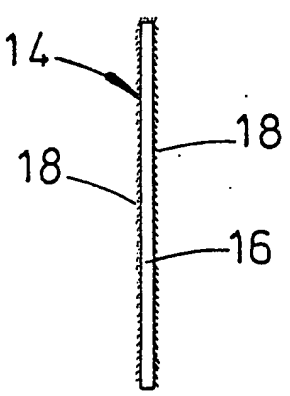

FIG. 3

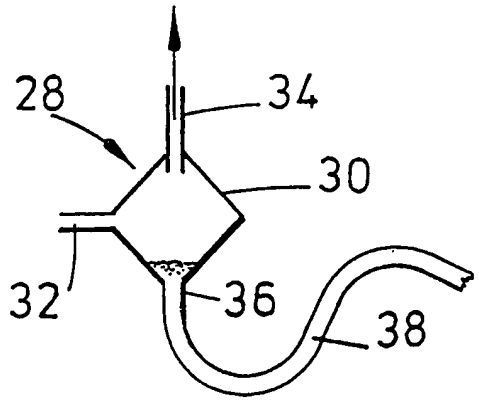

FIG. 4

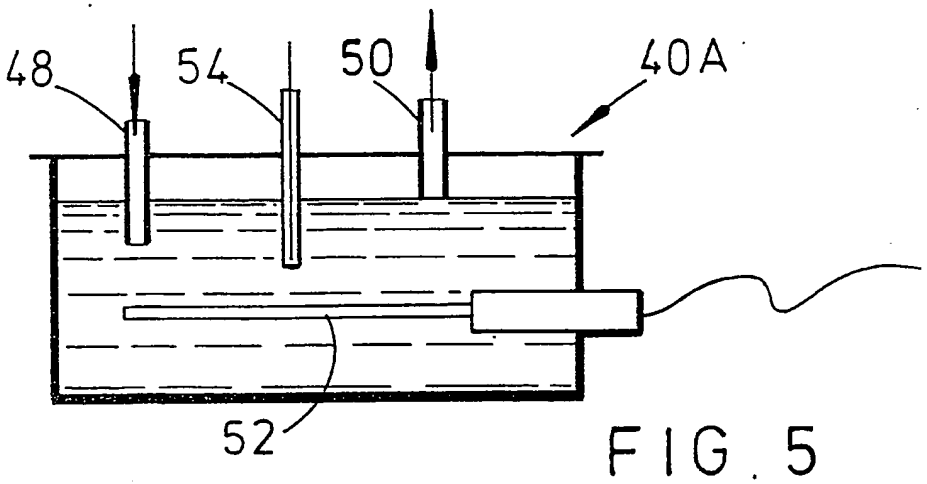

FIG. 5

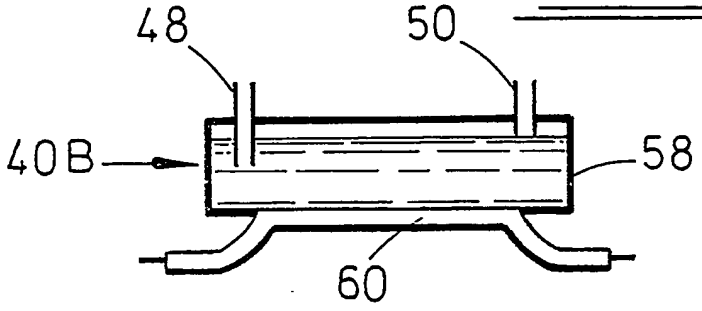

FIG. 6

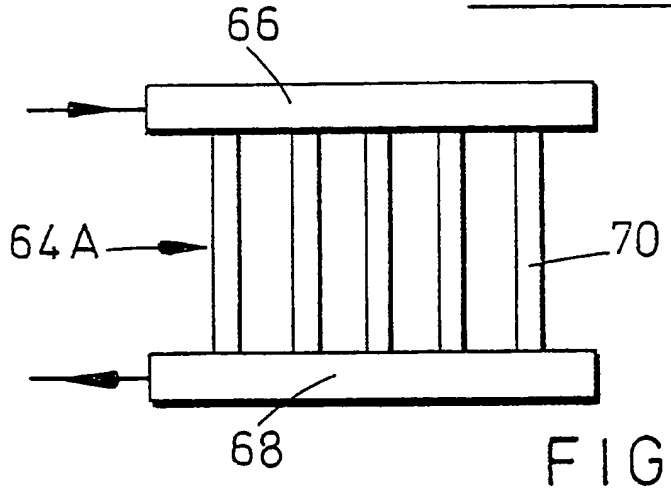

FIG. 7

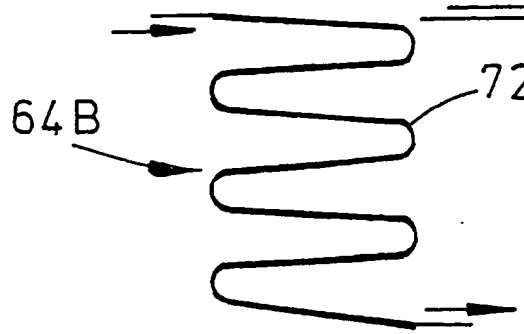

FIG. 8

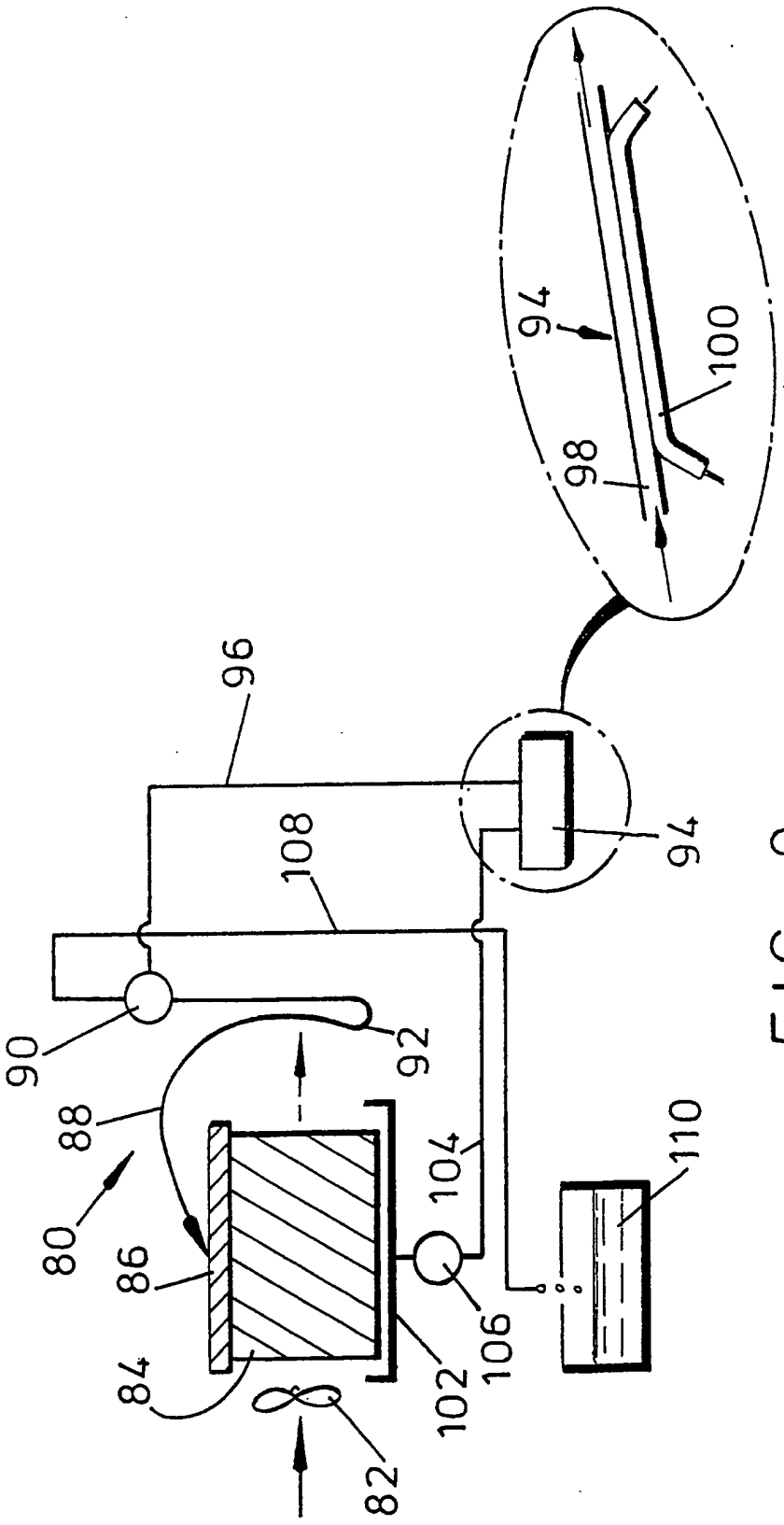

FIG. 9

Title: Dehumidifiers

DESCRIPTION

This invention concerns dehumidifiers.

Conventional dehumidifiers operate by taking in air, cooling the air to cause condensation of water vapour and releasing the dehumidified air. The condensed water has to be removed periodically from the dehumidifier.

An object of this invention is to provide an alternative type of dehumidifier.

According to the present invention there is provided a dehumidifier in which water vapour is removed from air passing through the dehumidifier by absorption.

In a preferred form a dehumidifier of the invention provides a water absorbing substance over which air to be dehumidified is passed and thereby causing removal of water vapour from the air. Any suitable water absorbing substance may be used but it is preferred that it should be one that may be provided in liquid form. Particularly suitable as the water absorber may be a relatively concentrated solution of a water absorbing chemical compound. A relatively concentrated aqueous solution of lithium chloride is especially suitable for water absorption.

The water absorbing substance may be caused to run down one or more absorber plates past which the air to be dehumidified is caused to flow, such as by action of a fan. Preferably a plurality of substantially parallel plates will be provided in dehumidifiers of the invention. The plates are preferably such as to provide low air resistance but high surface area. Suitable plates will have textured surfaces to provide additional surface area compared to a flat surface. For example, the plates may be formed of fibrous material, such as glass fibre tissue possibly on a rigid former, such as of plastics sheet, eg. acrylic polymer.

An alternative method of causing water absorbing substance/air contact may be to provide the substance on a random fibrous three dimensional matrix, such as of glass fibre or plastics foam.

The absorbing solution is passed to a distribution means whereby the solution is substantially evenly distributed over the or each absorber plate. The distribution means preferably comprises a first layer of material across which liquid can spread preferably by capillary action. A suitable material for this purpose has been found to be paper, such as microfine glass fibre paper. To prevent over saturation of the first layer, a second layer above the first may be provided that is capable of holding a

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reservoir of absorber solution whilst releasing sufficient to the first layer to maintain it in a saturated state, which state provides for relatively even distribution of liquid over the entire area of the distribution means. The second layer is preferably also a fibrous material, for which microfine glass fibre paper has been found to be suitable.

The second layer also has the ability to even out supply of absorber liquid to the first layer. Furthermore, absorber liquid may be fed onto the second layer from a channel across its width to enhance substantially uniform spread of absorber liquid over the distribution means.

When the absorber liquid is a concentrated solution of water absorbing substance, that may be provided by concentrating a weaker solution thereof such as by heating, say in a boiler. The heated solution may then be passed to a steam/liquor separator, where steam is taken off, cooled and collected in a reservoir which may be emptied periodically. The steam may be used by means of a heat exchanger to provide at least some of the heat required to concentrate the absorber liquid. The liquor which is now a more concentrated solution is fed to the distribution means, preferably via cooling means, such as a cooling loop.

The above system allows liquor that has passed

down the absorber plates, and so as has been diluted, to be collected and returned to the boiler to be reused. In order to prevent return of liquor from the boiler to the absorber plates due to back pressure it is preferable to include a non-return valve between the absorber plates and the boiler.

The passage of the steam/liquor to the separator is believed to be due to pressure from the boiler and/or to entrainment of liquor by the steam. However, if is envisaged that a pump, such as a peristaltic pump, may be used to transfer steam/liquor to the separator. On the other hand, separation of the steam from the liquor could be achieved at the boiler itself and a pump used to transfer the liquor to the absorber plates.

For lithium chloride an initial concentration of about 30% by weight is envisaged with heating taking that upto about 40% by weight. Heating of the dilute solution should preferably be above the boiling point of lithium chloride at 30% by weight concentration which is approximately 125 degrees C. Thus, a boiler temperature in the range of 125-150^{o}C, preferably about 135 degrees C, is believed to be suitable.

The boiler itself should be capable of withstanding both the temperature required of it and chemical action by the absorber. Copper clad boilers may be suitable as may boilers of glass or of high

temperature plastics. Heating of the boiler contents is preferably by means of an electrical heating element within or in contact with the boiler or a liquid carrying tube thereof and temperature sensing means may be provided to enable temperature control.

The liquor/steam separator preferably comprises a chamber having a steam/liquor entry, an upper opening for steam escape leading to means for condensing the steam and a lower opening for liquor collection leading to the distribution means, preferably via a steam trap. The condensed steam is preferably collected in a reservoir. The reservoir preferably has level sensing means in order to indicate when emptying is required.

The invention will now be further described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows schematically a dehumidifier;

Figure 2 shows schematically water absorption means of the dehumidifier of Figure 1;

Figure 3 shows an absorber plate of the absorption means of Figure 2;

Figure 4 shows schematically a liquor/steam separator of the dehumidifier of Figure 1;

Figure 5 shows schematically one form of boiler suitable for the dehumidifier of Figure 1;

Figure 6 shows schematically another form of

boiler suitable for the dehumidifier of Figure 1;

Figure 7 shows schematically one form of condenser suitable for the dehumidifier of Figure 1;

Figure 8 shows schematically another form of condenser suitable for the dehumidifier of Figure 1; and

Figure 9 shows schematically an alternative form of dehumidifier.

Referring to Figures 1 to 8 of the accompanying drawings, a dehumidifier generally referred to as 10 comprises in a case, a fan 12 for drawing air to be dehumidified past a series of parallel water vapour absorber plates 14. The fan 12 is shown blowing air through the plates 14 but could be arranged to suck air through the plates. The plates 14 each comprise an acrylic sheet 16 faced with glass fibre tissue 18 (see Figure 2). The plates 14 are arranged below a distribution plate 20 comprising a lower layer 22 of microfine glass fibre paper and an upper layer 24 of microfine glass fibre paper (see Figure 2).

The distribution plate 20 received concentrated aqueous lithium chloride solution (approximately 40% w/w) via line 26 from steam/liquor, an upper outlet 34 for steam and a lower outlet 36 for the liquor. Line 26 includes a U-tube steam trap 38. The chamber 30 is formed of polypropylene, although corrosion resistant metal may alternatively be used.

The steam/liquor mixture is supplied from a boiler 40 via line 42. The boiler 40 may be of the type shown in Figure 5 or Figure 6. In Figure 5 the boiler 40A receives diluted lithium chloride solution (approximately 30% w/w) from a liquor collector 44 below the absorber plates 14 via line 46. The boiler 40 is made of double sided copper clad glass fibre laminate with solder welds and sealed with silastic. It will be appreciated that other materials may be used for the boiler subject to temperature and anti-corrosion requirements.

The boiler 40 has an inlet 48 for the diluted liquor, and outlet 50 for the concentrated liquor/steam, an immersion heater element 52 and a thermocouple 54. The heater is required to raise the temperature of the liquor in the boiler to about 135 degrees C and the thermocouple 54 is to monitor the temperature within the boiler so as to provide thermostatic operation of the heater.

In Figure 6, the boiler comprises a metal tube 58 of corrosion resistant alloy externally heated by means of a brazed section of cooker ring type heater 60. Otherwise, the boiler 40B operates in the same way as the boiler 40A of Figure 5.

It should be noted that the boiler inlet and outlet are well spaced apart in order to promote flow

and hence mixing of incoming dilute liquor with the contents of the boiler.

Steam released from the separator 28 passes via line 62 to a condenser 64. Figure 7 shows one form of condenser 64A made of copper tubing having a horizontal input tube 66 a horizontal output tube 68 and connecting vertical tubes 70.

An alternative condenser 64B (Figure 8) comprises a copper coil 72.

The condenser 64 is positioned so as to be cooled by air flowing through the dehumidifier. Water from the condenser 64 is collected in a reservoir 74 that has water level sensing means (not shown) to indicate when emptying is required.

In operation, concentrated lithium chloride solution is supplied from the boiler via the separator to the distribution plate from where it is spread in the form of droplets by capillary action onto and moves by gravity down the absorber plates. The absorber plates present a high surface area of the solution to a humid air stream drawn through he absorber plate arrangement by the fan. Water vapour is removed from the air stream by the lithium chloride solution thus diluting it. The diluted solution falls into the liquid collector to be delivered to the boiler.

The boiler is thermostatically maintained at 135

degrees C and delivers to the separator a mixture of concentrated lithium chloride solution and steam. The steam is separated off and condensed into a water reservoir.

The dehumidifier may include a humidity level sensor so that it only operates at a predetermined humidity level in the atmosphere.

Turning to Figure 9 of the accompanying drawings, a dehumidifier 80 comprises, in a case, a fan 82 for drawing air to be dehumidified past a series of water vapour absorber plates 84 (of the same type as 14 in Figure 1). Concentrated aqueous lithium chloride solution (approximately 40% w/w) is fed to a distribution plate 86 for the plates 84 via line 88 from steam/liquor separator 90 (see 28 of Figure 1). Line 88 includes a cooling loop 92 to reduce the temperature of the liquor and act as a steam trap in order to protect the plastics plates 84.

The steam/liquor mixture is supplied from a boiler 94 via line 96. The boiler 94 comprises a length of copper tube 98 along which is attached an electrical heating element 100. The boiler receives diluted aqueous lithium chloride solution (approximately 30% w/w) from a liquor collector 102 below the absorber plates 84 via line 104. Line 104 includes a non-return valve 106 to prevent pressure from the boiler returning

liquor to the plates 84.

Steam released from the separator 90 passes via line 108 to a reservoir 110. Lines 104 and 108 are arranged side-by-side to form a heat exchanger, whereby heat from the steam raises the temperature of the liquor entering the boiler to reduce the work required of the boiler and to help condensing of the steam.

The dehumidifier of Figure 9 operates generally in the same way as the dehumidifier of Figure 1.

CLAIMS

1. A dehumidifier in which water vapour is removed from air passing through the dehumidifier by absorption.

2. A dehumidifier as claimed in claim 1, wherein a water absorbing substance is provided in liquid form over which air to be dehumidified is passed.

3. A dehumidifier as claimed in claim 1 or 2, wherein the water absorbing substance is a relatively concentrated aqueous solution of a water absorbing chemical compound.

4. A dehumidifier as claimed in claim 3, wherein the water absorbing substance is a relatively concentrated aqueous solution of lithium chloride.

5. A dehumidifier as claimed in any one of claims 1 to 4, wherein air to be dehumidified is drawn through the dehumidifier by means of a fan.

6. A dehumidifier as claimed in any one of claims 2 to 5 comprising one or more absorber plates down which the water absorbing substance flows and past which air to be dehumidified flows.

7. A dehumidifier as claimed in claim 6 comprising a plurality of substantially parallel absorber plates.

8. A dehumidifier as claimed in claim 6 or 7, wherein said plates have a textured surface.

9. A dehumidifier as claimed in claim 8, wherein the

plates are formed of a fibrous material on a rigid former.

10. A dehumidifier as claimed in claim 9, wherein the fibrous material is glass fibre tissue.

11. A dehumidifier as claimed in claim 9 or 10, wherein the rigid former is of plastics sheet.

12. A dehumidifier as claimed in claim 11, wherein the plastics sheet is of acrylic polymer.

13. A dehumidifier as claimed in any one of claims 6 to 12 including distribution means for substantially even distribution of the liquid over the or each absorber plate.

14. A dehumidifier as claimed in claim 13, wherein the distribution means comprises a first layer of material across which liquid can spread and through which the liquid can flow.

15. A dehumidifier as claimed in claim 14, wherein said first layer is of fibrous material.

16. A dehumidifier as claimed in claim 15, wherein said first layer is of paper.

17. A dehumidifier as claimed in claim 16, wherein the paper is micro fine glass fibre paper.

18. A dehumidifier as claimed in any one of claims 13 to 17, wherein said distribution means comprises a second layer of material that is capable of holding a reservoir of absorber solution.

19. A dehumidifier as claimed in claim 18, wherein said second layer is of fibrous material.

20. A dehumidifier as claimed in claim 19, wherein said second layer is of microfine glass fibre.

21. A dehumidifier as claimed in any one of claims 14 to 20 further comprising channel means across the width of the distribution means for substantially even delivery of the water absorbing material.

22. A dehumidifier as claimed in any one of claims 4 to 21, comprising means for concentrating a weaker solution of water absorbing substance to provide said relatively concentrated aqueous solution of water absorbing substance.

23. A dehumidifier as claimed in claim 22, including a boiler for concentrating the weaker solution.

24. A dehumidifier as claimed in claim 23 further comprising means for separating steam and liquor from the boiler, whereby, the liquor is delivered to the absorber plates.

25. A dehumidifier as claimed in claim 24 further comprising means for cooling the liquor from the boiler prior to delivery to the absorber plates.

26. A dehumidifier as claimed in claim 23, 24 or 25 further comprising means for returning liquor from the absorber plates to the boiler.

27. A dehumidifier as claimed in claim 26, further

comprising a heat exchanger to utilise steam from the separator means to preheat liquor from the absorber plates prior to return to the boiler.

28. A dehumidifier as claimed in any one of claims 24 to 27 comprising means for condensing steam from the separator means and a reservoir for the condensed steam.

29. A dehumidifier as claimed in claim 28, wherein the reservoir has level sensing means.

30. A dehumidifier substantially as hereinbefore described with reference to and as illustrated in any of the accompanying drawings.

31. A dehumidifier as claimed in any one of claims 1 to 29 having a humidity level sensor.

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ʻaminer's report to the Comptroller under Section 17 (The Search Report)

Application number 9103193.0

Relevant Technical fields

(i) UK Cl (Edition K) B1L (LAE, LAH, LAJ)

(ii) Int Cl (Edition 5) B01D

Search Examiner

MISS M M KELMAN

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI, CHEMENG

Date of Search

21.3.91

Documents considered relevant following a search in respect of claims 1 to 31

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2047112 A (HELLMAN)	1 to 4
X	GB 0495734 A (DOW)	1 to 4, 22
X	GB 0495734 A (DOW)	1 to 4, 22
&	FR 2634667 A	
X	US 4939906 A (GAS RESEARCH INSTITUTE)	1 to 4, 22,23,24 26,28 at least
X	US 4915838 A (HONEYWELL) see figures 1 and 3	1 to 3, 6,7
X	US 4864830 A (RYHAM)	1 to 4, 22
X	US 4178158 A (TAKASAGO)	1 to 5, 22
X	US 3777456 A (LUND)	1 to 4, 22 at least
X	SU 709844 A (ODESSA ENGINEERING-CONSTRUCTION INSTITUTE)	1,2,22, 23, at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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